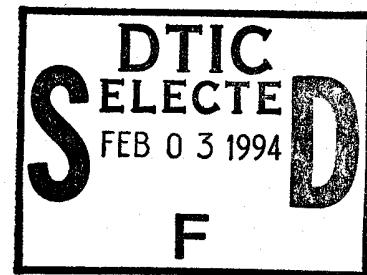


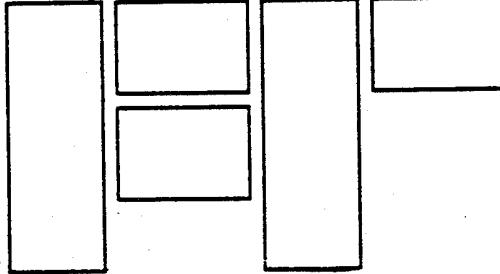
THE EDUCATIONAL FOUNDATION
FOR THE
FASHION INDUSTRIES

AT THE
FASHION INSTITUTE OF TECHNOLOGY

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FINAL REPORT
FOR THE
APPAREL ADVANCED MANUFACTURING DEMONSTRATION
(AAMTD)

FROM AUGUST 20, 1987 TO MARCH 25, 1994

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FINAL REPORT: ADVANCED APPAREL
TECHNOLOGY DEMONSTRATION
CONTRACT #DLA900-87-D-0016

EXECUTIVE SUMMARY

The DLA program to improve the acceptance of advanced technology in the domestic apparel industry resulted in the issuing of a contract to F.I.T. in 1987 to demonstrate this technology, investigate ways to economically justify its purchase, perform research and development to improve and apply it, and disseminate the resultant information.

Running for six and one-half years the program targeted toward both the commercial and military segments of the garment manufacturing business. F.I.T. activities concentrated on dress clothing, particularly trousers, slacks, and skirts and its demonstration site was set up to fully manufacture those items.

The demonstration site was equipped with over \$1.5 million dollars of the latest available apparel technology and garments were manufactured at first on a one day per week basis and later on two days per week. Strictly factory oriented until 1993 it was then expanded to include a Quick Response and Electronic Data Interchange Center which was opened in November, 1993.

Twelve major research and development projects were completed during the contract, ranging in scope from robotic pressing development to design of dress and fire protective clothing. The most successful were concerned with development of a supervisory training program, before-and-after analysis of a Unit Production System installation, and the re-design of Navy women's uniforms for contemporary fit.

**THE EDUCATIONAL FOUNDATION FOR THE
FASHION INDUSTRIES
AT THE
FASHION INSTITUTE OF TECHNOLOGY**

**FINAL REPORT
FOR THE
APPAREL ADVANCED MANUFACTURING DEMONSTRATION
(AAMTD)**

**CONTRACTED BY THE
U.S. DEFENSE LOGISTICS AGENCY
UNDER CONTRACT
DLA900-87-D-0016**

FROM AUGUST 20, 1987 TO MARCH 25, 1994

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Director of Advanced
Apparel Manufacturing
Technology Programs

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Executive Summary

The DLA program to improve the acceptance of advanced technology in the domestic apparel industry resulted in the issuing of a contract to F.I.T. in 1987 to demonstrate this technology, investigate ways to economically justify its purchase, perform research and development to improve and apply it, and disseminate the resultant information.

Running for six and one-half years the program, initially targeted toward both the commercial and military segments of the garment manufacturing business, gradually changed its focus toward military contracting almost exclusively. F.I.T. activities concentrated on dress clothing, particularly trousers, slacks, and skirts and its demonstration site was set up to fully manufacture those items.

An industry advisor group was formed of equipment and garment suppliers but soon became inactive due to contract restrictions. In 1991 it was re-formed to include only military contractors and their material suppliers. This group was more active and assisted F.I.T. in proposal and demonstration work.

The demonstration site was equipped with over \$1.5 million dollars of the latest available apparel technology and garments were manufactured at first on a one day per week basis and later on two days per week. Strictly factory oriented until 1993 it was then expanded to include a Quick Response and Electronic Data Interchange Center which was opened in November, 1993. The EDI portion, however, is still awaiting system integration but can demonstrate stand-alone EDI functions. Over 6,000 persons have visited the demonstration site during the term of the contract.

To assist potential purchasers of the production systems F.I.T. developed a market driven economic justification model which was widely published. Field response was poor, however, as it seemed too complicated for most producers of the size of military contractors. Work to develop a computer program to apply the model was aborted when it was learned that a number of applicable similar based programs were available from other industries.

Dissemination of the activity information of the project was quite successful. Over 2000 newsletters were sent to the industry every quarter and many articles and press items were published in trade journals and national magazines and newspapers. This generated considerable interest in the results of some of the research and development efforts.

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Twelve major research and development projects were completed during the contract, ranging in scope from robotic pressing development to design of dress and fire protective clothing. The most successful were concerned with development of a supervisory training program, before-and-after analysis of a Unit Production System installation, and the re-design of Navy women's uniforms for contemporary fit. Some projects were not continued into their productive stages due to a lack of responsiveness by the DLA.

Numerous benefits resulted from the program to F.I.T., other educational institutions, the DLA, and garment manufacturers. These were principally in technological and industry practice education and upgraded garment designs. Also, much was learned about how to make such a program more successful in the future as well as the near and long term research requirements needed to make the apparel industry more productive and competitive.

I. Background

During the early to mid 1980's a critical shortage of military uniforms developed for virtually all the service arms of the United States Armed Forces. This was due to a number of causes which, when combined, resulted in the inability of the Defense Logistics Agency (DLA) to find uniform manufacturers of the quantity and quality to meet its procurement needs. The situation became serious enough so as to have new recruits, instead of obtaining initial issue uniforms from DLA stock, be issued chits for purchase of post exchange uniforms or start basic training without a full complement of regulation clothes.

In order to alleviate and improve this condition the DLA embarked on several approaches. One was based upon the premise that the existing firms which traditionally bid on military clothing contracts had formed a virtual organization which blocked, either by superior and esoteric knowledge of how to do government business or by plain illegal conspiracy, other clothing manufacturers from submitting or obtaining successful bids. In short, the available pool of government clothing bidders had become much too small to satisfy even peacetime needs.

To expand this pool it was decided that better suppliers were needed that would be more competitive. However, there was a great concern that, as the total U.S. garment manufacturing base was being rapidly lost to foreign suppliers, the only way to increase the DLA pool was to assist the commercial apparel industry in stemming this shrinkage. The premise was that, if the total industry could be made more competitive, the government could select more competitive suppliers from it.

A major factor in improving the competitiveness in cost and quality, according to the government, was applied technology. The general state of the whole industry, and more so for the government contractors, was one of an extremely low use of existing garment making technology and a dearth of any new domestic technological developments. Competitive improvement was, according to the Government, directly related to technological improvement. To this end the DLA developed a program to infuse the domestic apparel industry with technology. It was to be done by demonstrating the latest available manufacturing technology and the means to pay for its application, dissemination of the results of applying technology, and the development of new technology where it was needed.

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This program was described in a Request for Proposal (RFP) written by the Production Management Support Office of the DLA and issued by the Defense Electronics Supply Center in 1986. Only educational institutions were eligible for contract awards apparently because of their non-commercial and technological research orientation.

In early 1987 contracts were awarded to three institutions, one of them being the Educational Foundation for the Fashion Industries at the Fashion Institute of Technology. The contract was to run for three years with an option for two more and a Government/F.I.T. share ratio of 47/53 percent. The additional two year option was exercised by the DLA based upon F.I.T.'s initial three year performance and ultimately extended one more year. This made the total Apparel Advanced Manufacturing Technology Demonstration (AAMTD) term at F.I.T. approximately six years.

The following is a summary of that six year effort as regards objectives, results and benefits achieved, lessons learned, and suggestions for future research.

II. Objectives

The primary objective as stated by the DLA in the contract Statement of Work (SOW) was "to increase the use of commercially available manufacturing technology by providing a demonstration site which is equipped with machines and management systems and which clothing manufacturers, researchers, and equipment and systems vendors can use to learn about the capabilities and limitations of advanced technology, solve manufacturing problems, experiment with new methods, train personnel, and manufacture test batches of apparel".

A secondary DLA objective was "to demonstrate the application of non-traditional capital investment criteria to the justification of advanced apparel manufacturing systems and equipment". A tertiary DLA objective was "to operate an Apparel Manufacturing Information Service (AMIS) to communicate the capabilities and limitations of advanced manufacturing technology to the apparel manufacturing community and to suggest directions for future research in manufacturing equipment and systems". This was to deal with F.I.T. site activities as opposed to technology efforts at other locations.

In addition to the above objectives, and to augment them, it was anticipated that short term (less than two years) research and development tasks would be needed to significantly advance the capability of the industry to meet the Department of Defense (DoD) requirements. These tasks, when needed, would be an additional effort above the main objectives and funding of the base, or core, AAMTD contract. It was intended that the short term R&D funding would come from one or more sources such as DLA, other DoD organizations, federal, state, local departments or agencies, or non-government organizations. These tasks were to be ordered by the DLA on relatively short notice (underline added) throughout the life of the contract.

It is interesting to note that the original objectives did not specify that the target audience of the efforts was limited to DLA contractors. On the contrary, the Background section of the RFP and contract discusses the general domestic industry, "including DLA suppliers".

On the 24th of August, 1990 the AAMTD contracting office was transferred from the Defense Electronics Supply Center to the Defense Personnel Support Center (DPSC). This was approximately three years into the contract and, although there were no contractual changes regarding objectives, certain influences and actions at DPSC indicated that the original objectives were not currently popular, particularly the lack of limits to only Government contractors. Both core contract efforts and R&D project proposals were being gauged against the immediate mission and needs of DPSC rather than the short and long term technological needs of the entire domestic apparel industry. This objective shift was further developed at a series of meetings at DPSC with contracted institutions, DPSC and DLA personnel, and government contractors in attendance.

Shortly after that time, F.I.T.'s focus also shifted, because of the desire to satisfy the customer, to exclusively military garment work. The demonstration site used military patterns exclusively, the contractually required industrial advisory board (or coalition) was re-organized to include only Government contractors, and the short term R&D proposals were justified principally on how they would directly benefit the DPSC or DoD mission (Some projects which were underway were canceled by DPSC based on this criterion).

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However, even though it became very clear that DPSC would have to be served for the remaining contract years, their specific needs were never at all defined. Much of the remaining effort became a guessing game as to what would simultaneously please DPSC and the Production Management Support Office (which office was in charge became quite blurred).

Therefore, R&D project proposals concentrated on uniform design, military specification based pattern system development, and Quick Response/Electronic Data Interchange for the military instead of industry generic technical developments. The core project, however, remained much as before and was open to everyone, commercial and military. But by the beginning of the sixth year there was virtually no direction or dialogue towards F.I.T. by either DPSC or DLA.

III. Results

a) Demonstration site

Although the AAMTD contract was awarded in early August, 1987 it was not until November of that year that a site director, Mr. Henry A. Seesselberg, was employed. Therefore, serious efforts at setting up a demonstration site did not begin until January, 1988.

The F.I.T. proposal to the DLA indicated that all the military dress garment types (trousers, coats, skirts, outerwear, etc.) mentioned in the RFP would be manufactured at the facility. However, this was based upon a limited knowledge at F.I.T. of the complexities of military clothing, particularly for dress uniforms, and a somewhat simplistic viewpoint of the typical mass production techniques that would be required. A thorough analysis of the capacity of the demonstration area, available equipment and labor skills, and possible other resources by the new director indicated that the concentration on one garment type would better demonstrate the available technologies working in concert to effect more efficient and higher quality garment manufacture. Therefore the initial plans for the production laboratory centered around the production of men's dress trousers for the Army utilizing current specifications. Some capability to do certain difficult mechanized dress coat operations would be included where they either overlapped those of trousers (ie - pocket welting, serging, etc.) or could stand alone off line from the production system (Military dress coats require over 140 operations whereas trousers only require about 50). Plans were started, however, to add dress coats to the production in 1989.

The major part of 1988 was devoted to re-engineering the site from a little used machinery laboratory containing much obsolete and non-pertinent equipment (skirt pleater, die press, etc.) and forming a coalition of cooperative firms to assist in creating a modern demonstration. The initial members of this coalition were a mixture of equipment, material, and software suppliers with some union representation. A meeting was held in early November, 1987 to apprise them of the details of the contract. At that time they were told that contract funds, even though initially approved by the DLA for equipment acquisition, could not be used for equipment purchases because of a DLA error and that they were requested to supply the necessary items on consignment. This revelation caused some firms to lose interest and a number of them ceased coalition activity. However, many important companies continued support and, using them for planning purposes, the demonstration site was laid out.

During the summer of 1988, over some vigorous objections of the faculty, almost all of the old equipment was scrapped and the new equipment, negotiated from the remaining coalition members, was moved in and installed by two new staff members, an equipment technician, Mr. Anthony Ferraro, and a sewing technician, Mr. Henry Smith, hired specifically for the contract. The goal was to be able to perform every operation for MIL-T-439576 trouser manufacture from marker making through finish pressing utilizing the most modern available technology. By October, 1988 this was accomplished.

On November 10, 1988 a grand opening was held to launch the operation and make it available to the industry. This was attended by many dignitaries from governments, industry, and the military. Shortly afterwards appointments were being set up with industry members to observe the equipment and discuss the possibilities of its use to improve their operations. Initially, there was considerable interest generated from excellent press coverage and visits by the AAMTD staff. The cost of travelling to New York City, however, discouraged many firms not from the local area and soon the visitors became quite limited to those near the city. This left a much smaller client base due to several factors as follows:

1. Most of the New York City area manufacturers make women's wear, particularly blouses, dresses, and sportswear. Interest in men's dress trousers is almost nil.
2. The NYC contractors are extremely archaic in their methods and technologies, some still using "whole garment" techniques. The local industry is virtually devoid of the simplest technology advances beyond 1950.

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The psychological and financial gap between what they have and what the AAMTD shows is tremendous causing a loss of reality from their viewpoint.

3. The AAMTD did not operate as a factory with workers and steady production. This also detracted from reality perception.
4. The local industry believed that the facility, as it was sponsored by the DoD, was only interested in, and would only be helpful to, military contractors.
5. The facility was thought to be threat to local consultants who discouraged participation by their clients utilizing facts in 1 through 4 above.

The facility kept improving, however, with more and better equipment and systems being installed. During 1989 a number of improvements in military trouser design and manufacture were instituted at F.I.T. and some were accepted by the military departments. Some of these improvements were the replacement of the "on seam" side pocket with a slash pocket while still maintaining the dress stripe allowing use of an automatic side seamer; re-engineering the waistband assembly to allow the use of automatic machinery; and replacing the back pocket with pre-made ultrasonically sealed material eliminating several labor steps. A number of samples of garments with these changes were made and submitted to DPSC for evaluation. Several other batches of trousers were also made to the specifications and submitted for quality inspection. They easily passed indicating that the AAMTD could produce military spec garments with advanced technology manufacturing methods.

During 1989 plans to produce dress coats continued. The demonstration of dress coat manufacturing technology required a considerably different approach than that of trousers. Whereas the trousers, with approximately fifty operations, could be fit into the laboratory including even the pattern digitizing and marker making, an analysis of the Army coat disclosed 165 discreet operations, excluding marker making. A review of F.I.T.'s resources revealed that we did not have the room, manpower, or total skills required to manufacture a complete coat. Therefore, we decided to concentrate on those coat operations that had the following characteristics:

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1. The operation is in the critical cost/skill/throughput time path
2. There is advanced technology available to upgrade it.

In order to get a consensus of what these operations might be, we convened two meetings of coalition members. The first meeting was with several military and civilian coat manufacturers to determine what would interest them if it could be set up in the AAMTD. The second meeting was with suppliers of coat manufacturing equipment to see if they could match the requests.

The only real match between garment manufacturers requests and equipment suppliers willingness to lend equipment to the AAMTD was in the area of profile stitching. We, therefore, arranged to have such equipment sent here and set up for demonstration. From the same suppliers of this equipment (AMF) we were also able to obtain some advanced buttonsewing equipment for demonstration, as well as, a computerized automatic fabric costing system. This latter system could be used in resolving difficulties in estimating government furnished material for military garment contractors.

A laboratory manager, Mr. Josef Korngruen, was hired in 1989 with vast experience in all aspects of sewn products manufacturing technology and management. His skills were utilized to both improve the trouser manufacturing at F.I.T. and consult with industry visitors regarding applications of the demonstrated technology.

The third year, 1990, of demonstration site activity was marked by a strong effort to stimulate industry participation by addressing the dress trouser and dress coat operations. However, after acquiring some very sophisticated technology for coat manufacture to add to that in place for trousers, industry activity did not increase. This is attributed to the fact that the menswear business started a serious slowdown and, as most of its manufacturing is located far from the New York area, it was too difficult and expensive for potential users to travel here.

Interest from the women wear segment, though, started to build and plans were made to switch demonstrations activities toward this segment. Permission was obtained from the DLA to focus on women's slacks and skirts as these were of interest to the armed services as well as the local civilian enterprises. The DLA also agreed to support a one day per week factory environment with a complement of machine operators.

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The weekly operation was started September 27, 1990 when seven operators, supplied by the ILGWU, started training. Prior preparatory work was done in obtaining Army skirt and slacks patterns, purchasing civilian and military fabrics and findings, and completing markers and cuts. Full operation for public demonstrations started in November, 1990.

The following are the significant laboratory activities, milestones, etc. for the 1989-1990 contract year.

- Autojig Profile Stitcher loaned by AMF. Difficulties encountered in obtaining military patterns from DPSC for coats.
- Meetings with ILGWU started to explore joint ergonomic research work.
- Meetings with New York City Industrial Technology Assistance Corp. to explore assistance to local manufacturers.
- Very successful roundtable seminar on flexible manufacturing held.
- Proposals to re-design Army trouser waistband and back pocket assembly accepted by DPSC.
- AAMTD hosted GGT Accumark users workshop.
- Eton UPS 2001 computer controls installed, system upgraded.
- 75 persons attend introduction of AMF Tiemaster at the AAMTD.
- ILGWU requests AAMTD activity in women's wear. Technology seminar held jointly at FIT for the member firms.
- Dress coat patterns and samples for profile stitching finally received from DPSC (4 months) and sent to equipment vendor (AMF) for fixture fabrication
- Columbia University School of Architecture approves AAMTD for their students to learn factory layout for New York City industrial park.

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- AMF pin-tuck machine for women's wear received and demonstration started.
- Discussion held with MACPI to demonstrate new pressing system at the AAMTD.
- Cybrid auto costing tests complete. Results show GGT AM-5 and Cybrid have clear advantages over conventional costing methods. Cybrid shows significant material cost savings for volume fabric users.
- Student activity in AAMTD increased in time study, plant layout, and marker making and grading.
- AAMTD laboratory starts marker making, grading, spreading and cutting of proposed Navy women uniforms designs.
- Second flexible manufacturing roundtable seminar held.
- AAMTD examines large skirt and slacks military size tariff caused by the one piece waistband. Recommendations for a two piece waistband, allowing alterations and cost savings, were put on hold by DPSC/DLA.
- Plans for demonstration of women slacks and skirts completed.
- AAMTD continues construction of sample garments for the proposed Navy uniform design (slacks, skirts and coats).
- ILGWU agrees to supply labor for weekly factory operation.
- CBS television uses AAMTD for filming segment on technical education.
- Very successful "Key Issues" seminar, hosted by the AAMTD held. 250 attendees heard six top management speakers discuss the retail concerns as they affect the whole apparel industry. AAMTD promotional video distributed to the conference attendees.
- AAMTD participates in the annual meeting of the American Society for Quality Control Textile and Needle Trades division.

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- AAMTD personnel visit the clothing R&D facilities of the Army, Navy, and Air Force to explore use of the demonstration facility in problem solving.
- AAMTD makes presentation at a technology seminar for the Manhattan Boro Development Corporation.
- Patterns proposed for changeover of the laboratory to a women's wear demonstration. Difficulties encountered in finding an industrial civilian partner due to poor perception of operations reliability because of scholastic environment.
- Rensselaer Polytechnic Institute Center for Manufacturing Productivity staff visits the AAMTD for joint venture discussions.
- Exploratory meetings held with Polytechnic University (Brooklyn, NYC) about possible CIM activity.
- AAMTD/GGT meet on new product development cooperation possibilities.
- Work on lab conversion to women's wear completed. ETON UPS is re-programmed. Civilian industrial partner still being sought.
- Work started on grading patterns and creating 150 markers needed for the final proposed Navy women uniform design.
- Specific operators requirements for weekly factory operation submitted to the ILGWU. Negotiations start to obtain some additional required equipment.
- Evaluation of Lamsteel ergonomic work station with the ILGWU delayed do to operator/table interface difficulties.
- AAMTD personnel attend JIAM apparel equipment exhibition in Tokyo. Huge show of CAD, UPS, and computerized cutters, many of which are not marketed in U.S. Many CIM demonstration of dubious cost effectiveness. Suppliers technically more advanced than U.S.
- 123 markers completed and cut for navy women uniforms.
- Beisler America Pocket welting machine arrives for use on women's wear demonstration.

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- Work continues on Navy women uniform design with further marker development and cutting, re-cutting due to assembly subcontractor problems, and assembly of subcontractors omissions.
- New Lamsteel workstation received and made operational. ILGWU notified for their preparation of an R&D proposal to us.
- Army women skirts and slacks chosen for start up of weekly production.
- Lab activity on Navy women uniforms completed and shipped to the Navy (Orlando) for fit tests.
- Operators of weekly factory demonstration arrive for training.
- Coalition of ILGWU, Lowell University, and Mt. Sanai Hospital start on proposal to evaluate the Lamsteel Ergonomic workstation.
- Obsolete presses and fabric inspections machines sold to expand lab space.
- Presentation made to Business and Technology Division of F.I.T. for integrating the AAMTD operation into the curriculum.
- AAMTD personnel meet with DPSC to explore offering technical advice on military specifications to potential and actual contractors. Concerns regarding AAMTD being considered a DPSC agent resulted in DPSC forbidding this activity.
- AAMTD personnel attend Bobbin Show, participating in several technical and management seminars as well as making potential industrial partner contacts.
- Metropolitan Fashion Center of Greater New York requests the AAMTD to assist in setting up a new 39,000 square foot factory.
- AAMTD written up in Daily News Record, Women Wear Daily and New York Times.
- Work started to re-form coalition for women's wear work. Industry advisory committee formed.

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During the 1990-1991 year of demonstration site operation the activity was rather constant but at a modified level. The production line had been converted from men's trousers to women's slacks and skirts to develop more interest from the relatively local firms which are predominant in women's wear. However, the serious downturn in the industry and the shortage of capital funding discouraged many people from considering advanced technology purchases. As a result, little interest was seen from the domestic industry. Considerable interest, though, was evident from a number of off-shore organizations.

Another deterrent to greater activity in the plant was the difficulty which the operators had in adapting to the newer equipment. The ILGWU was our sole source for operators and they all had many years experience in the local industry which is quite archaic by national and international standards. Therefore, these operators could not break old habits of work and we could not properly demonstrate the advantages of the newer equipment such as programmable sewing machines, etc. We feel that this might be a subtle lesson in why more newer equipment does not reach its potential in the domestic industry.

The laboratory operation schedule was once per week (Thursday) when slacks and skirts made to Army and Navy specifications were produced and donated to the New York Mayor's Office for the Homeless. Plans were made for students to operate the system every Tuesday. Results showed that they were much more adaptable to newer ways and the Thursday operation was phased out.

Significant events for this 1990-91 year were as follows:

- Pilot plant output starts at 50 garments per day.
- Two offices added to facility for R & D Coordinator and Laboratory Manager.
- Facilities re-arrangement (obsolete equipment removal) plans started.
- Pennsylvania Modernization Center requests assistance for contractor.
- Pilot plant featured in Marketing Computers Magazine.
- CNN films research activities in laboratory.
- Coalition meeting with women's wear trade associations held.

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- Pilot plant production increased to 60 garments per day. Quality improves.
- Reeves agrees to supply fabric below cost.
- Peacoats for new R&D project cut.
- Byte Systems computer costing system installed in laboratory.
- Tests on AMF Autojig completed. System returned. Too many fixtures required for military designs.
- Accumark CAD system upgrade plans made with GGT.
- NY Industry Technology Assistance Coup meets with AAMTD to plan industry service.
- Burlington agrees to supply fabric below cost.
- Navy peacoat cutting, fusing, and pocket setting completed.
- Air force requests computer garment design demo for new uniforms using their personnel. Canceled due to lack of sufficient training time made available by them.
- Meetings held at Computer Design, Inc. for applying pattern recognition systems to military coat inspection.
- AAMTD's findings on overlapping size tariffs supplied to the DOD C&T Board.
- Meetings held with Dimensional Measurement Systems, Inc. for exploring automatic 3-D body measurement.
- Computerized cutting for NY Garment Industry Development Corporation operator training school commences.
- AMF Buff Pocket setting Machine received. Evaluation started on military coat applications.
- ISRATEX visits AAMTD for advice.
- Contract received from Army Natick to produce prototype and fit test slacks and skirts.

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- Advanced operator trainees at the NY Garment Industry Development Corp (GIDC) use laboratory for experience on advanced equipment.
- Kansai Special offers Modular Manufacturing Automatic Carousel system to AAMTD.
- Pocket samples produced on AMF Buff Pocket Machine sent to Natick (Army) for review.
- AAMTD Personnel meet with Army and Navy R&D at Natick for discussions regarding pilot plant and R&D activities.
- Parts cut for Army prototypes and first articles produced with minor suggested changes. Approved by Natick.
- New CAD System (Accumark 320) received from GGT.
- Weekly production increases to 85 garments per day.
- 110 Prototype slacks and skirts produced for Army R&D. Approved by Natick with no re-work.
- Evaluation of AMF Buff Pocket Setter completed. Sketch drawing submitted to Army R&D for inclusion in spec modification. Design improvement recommendations submitted to AMF.
- New UPS computer installed. Upgrade software loaded.
- AAMTD participates in CMA technology seminar.
- AAMTD meets with AAMA Government Contractors Committee regarding assistance.
- AAMTD personnel visit Parris Island and Fort Jackson recruit centers.
- Army prototype and fit test project put on hold by Natick.
- AMF Buff Pocket Machine returned. Specifications modification issued by Army R&D allowing its use.
- System design for Kansai Special completed. Supplier starts modification. Juki agrees to supply motors.

- AAMTD personnel attend IMB in Cologne.
- Weekly skirt and slacks production demonstration continues.
- Plans for extra day pilot plant operation with students made.
- AAMTD meet with DPSC to request direction.
- Laboratory activity continues production for GIDC.
- AAMTD meets with Cornell University to explore apparel industry extension service in New York.
- Voice of America tapes AAMTD activities for European broadcast.
- New Coalition Advisory Steering Committee formed with government contractors for activity steering.

As shown by the above, laboratory activities were considerably reduced as the year progressed. Besides the loss of industry interest due to economics, the virtual demise of short term research activity further depressed industry interaction.

The contract year, starting in the third quarter of 1991, was marked by increased production efforts and a very damaging and sudden cessation of DLA funding during the latter part of the year. This funding gap was caused by a very detailed and lengthy government audit ordered by DPSC for reasons never explained to F.I.T. It resulted in the layoff of the sewing operators, the production manager, and a sewing technician and lasted from September, 1992 through March, 1993. During that time the activities at the demonstration site were virtually nil thereby causing a severe disruption in demonstration schedules and a loss of the skills of the operators who had to find other employment.

Before the funding stopped, production increased with the order from Army R&D (Natick) for 220 each of skirts and slacks for the new design.

The year also was notable for the re-formation of the contractually required industry coalition. Whereas the original contract intent was to serve the whole industry, the coalition was therefore made up of mostly commercial firms. After DPSC assumed the role of the contracting office and impressed the requirement of

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principally serving the military contractor base, the old coalition was dissolved (it had become somewhat inactive due to lack of sales activity resulting from the AAMTD) and The Government Contractors Advisory Committee was formed. Its membership was:

Reeves Brothers	-	Mr. Gordon Bronstein
Duro Industries	-	Mr. Wayne Von Stetton II
Harris Mfg. Co.	-	Mr. David Harris
Vanderbilt Shirt Co.	-	Mr. Michael Mansh
Ippoliti, Inc.	-	Mr. Nick Ippoliti Jr.
Kings Point Industries	-	Mr. Harold Rosenbaum
Military Fabrics Co.	-	Mr. Richard Brusca
QST Industries	-	Mr. Arthur Brause
Waterbury Companies	-	Mr. Donald Peterson
J. Spiewak & Sons	-	Mr. Roy J. Spiewak
Apparel Manufacturing Corp.	-	Mr. Ronald Levine
Emsig Manufacturing Corp.	-	Mr. David Fischler
Propper International	-	Mr. Earl Weinman
Isratex	-	Mr. A. Brin
Southern Apparel Co.	-	Mr. David Bulluck

This group was quite active, holding a number of meetings at F.I.T. and hosting visits of AAMTD personnel at their factories. A firm focus developed early in the group on meeting the "zero AQL" edict issued by DPSC. F.I.T. was asked by the group to develop a proposal to the DLA for developing a test application of Total Quality Management to one or more military contractors operations. This was done and presented to Mr. Robert Scott, Special Assistant, Defense Contract Management Command, and his staff at Cameron Station, VA (It was simultaneously sent to the COTR at the DLA). While the presentation was politely received, no reply or action was ever given to it. The Government Contractors Advisory Committee then started to lose interest, for the most part.

Significant events for the 1991-92 year were:

- Evaluation of Kansai Carousel system completed.
- Sales program for Supervisory Training video tapes started.
- Demand for GIDC cutting increases.
- 440 garments produced for Army Natick for new design fit tests.
- Modular manufacturing introduced.

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- ETON system upgraded from 2001 to 2002 (mix bundles and UPS).
- New Jersey Institute of Technology designates the AAMTD as its apparel industry resource.
- F.I.T. re-makes the Clemson Modular Manufacturing videotape for local (NYC) consumption.
- F.I.T. AAMTD applies to New York State for support for a New York Center for Apparel Science & Technology ("Develop a Business Plan" project result).
- AAMTD joins Council of American Fashion.
- DLA halts funding in September for remainder of the year.
- Proposal sent to DLA to expand production to 2 days/week and establish a Quick Response/EDI Center.

The last year of the DLA-AAMTD contract started on March 25, 1993 after a six month lapse of funding. The initial months were spent trying to regain the momentum and skills lost during the funding hiatus. As the proposal for the QR/EDI center did not anticipate this interruption considerable time was lost in establishing the center. Faculty lost interest and management moved cautiously anticipating another funding disruption.

Nevertheless, six new student operators were recruited from the evening division for the two day per week operation and started training on May, 1993. Also, plans were started for the new QR/EDI center that month. A committee of software and hardware suppliers was constituted for planning assistance consisting of the following firms:

Gerber Garment Technology
Microdynamics
Tactician International
NCR
Symbol Technology
Monarch Marking Systems
Merchant Data Solutions
Sterling Software
Accounting Wiz

The QR/EDI center was operational in September, 1993 at which time efforts to link all the software together for a real time seamless EDI demonstration was started. However, lacking sufficient expertise in systems integration the F.I.T. AAMTD staff

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greatly underestimated the effort required to do this and, although the center can demonstrate stand-alone EDI and QR software and hardware (bar coding, retail sales, manufacturing) as of this writing a true Point of Sale through Manufacturing data flow is not possible. Work will continue after the end of the AAMTD contract to develop this capability.

The 6th contract year also showed renewed interest by the Government Contractors Advisory Committee in urging F.I.T. to get involved in ISO9000, shared production, civilian outlets, common commercial/military garment design, and EDI training. Little progress was made however, in realizing these ideas due to lack of resources and dialogue with the DLA.

Significant 6th year activities were:

- Government audit completed - 6th year funds released.
- Quick Response/EDI Center established.
- Demonstration Site reformatted to accommodate QR/EDI.
- GGT installs 2001 model fabric cutter (replacing S91 model).
- F.I.T. donates ten 486 computers to the EDI facility.
- New York State rejects F.I.T.'s proposal to establish the New York Center for Apparel Science and Technology.
- Two day per week production started.
- Navy R&D (Natick) contacts F.I.T. to design protection clothing for rocket fuel fires.
- EDI demonstration technician hired.
- Modular manufacturing merged with Unit Production System.
- QR/EDI center opens on November 10, 1993.

At the end of the 6th year, and the DLA contract, the demonstration was still operating well. Plans for continuation of the QR/EDI center, however, will depend upon finding other funding sources.

The total number of visitors to the F.I.T. AAMTD for the six and one half years of operation totaled over 6300 persons. The vast majority of these visitors were from academia (students, faculty, administrators), either F.I.T. or many other domestic and foreign institutions. About 8 percent of the visitors were from domestic garment manufacturing companies and military contractor visitors were very few. The following is a breakdown by visitor category:

Academia	5,385
Domestic Industry	522
Foreign Industry	265
Other (Government, Media, etc.)	160

b) Non Traditional Capital Investment Criteria

While the principal thrust of the core contract was to demonstrate to the industry the advantages of advanced production technology, its success was linked to the ability of the industry to pay for its acquisition. Conventional tax laws and their accounting requirements usually failed to indicate a savings when adopting new equipment and systems. Items such as improved quality, ability to meet competition, lower work-in-process, faster throughput time, etc. had no place in the traditional payback systems in common usage. Therefore, a major part of the AAMTD project effort was to develop a payback method which would take these and other so-called "intangible" factors into account. Early in the project effort Mr. Irving Kaplow and Mr. Henry Seesselberg did much research into the subject and combining the results with their own long term experience in the industry, developed a "flow-through profit" method of analyzing the total enterprise economic advantages of adopting technology from product marketing back through manufacturing and purchasing. These findings were published in Bobbin Magazine in February 1989 under the title "Intangibles Count in ROI Calculation." Subsequent polls of the industry showed a fair interest in the subject but most corporate respondents seemed too locked in to the classical accounting methods to either understand or implement the results. Owner-operators of companies, however, seemed to already operate in this non-traditional way and, in fact, they were the main source of usable research data in the method's development. Our conclusion was that this subject was not of paramount concern to the industry.

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We did find, however, that the hard goods industries were using techniques extremely similar to those developed at F.I.T. A number of firms were found using computerized spread sheet analyses based on flow-through profit for the total business enterprise and quantifying the "intangibles" with market driven factors. All required the development of an overall business plan before capital investment was considered and for the most part they were therefore quite complex. Our conclusions, issued in a report to the DLA in 1990, were that there was no simple way to effectively predict the effect of capital expenditures on a business but, for those who would take the effort to properly define their business and goals, a number of viable justification methods were readily available in both the soft goods and hard goods industries. This viewpoint has since been re-enforced by the non-traditional payback computer programs developed by the Georgia Tech and Clemson AAMTD's. They are merely re-statements of the software described in the F.I.T. report. This report should be available from F.I.T. or the DLA.

c) Apparel Manufacturing Information Service (AMIS)

Prior to contract award F.I.T. had proposed that the AMIS would take the form of a quarterly newsletter which would mostly describe the activities at the AAMTD. For the most part, that was done throughout the six contract years. Some of the feature articles and editorials appearing in the newsletters are as follows:

- Rensselaer Successful in Simulating Drape
- Handbook Readied for Automated Garment Design
- FIT;s Navy Uniform Fit!
- Update: Improvement of Factory Equipment Use
- Navy Peacoat goes Unisex
- Modular Manufacturing - Some Case Studies
- View Latest Automatic Equipment at F.I.T.
- Quality Improvement for Dress Coats
- Computer Based Costing Seminar Rated High
- FIT Projects Nearly Complete

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- Bundle System vs. UPS - Before and After
- Technology Quiz
- Equipment Evaluation Results in Army Coat Spec Changes
- Capital Expenditures Payback Evaluation Programs Available
- FIT/AAMTD Opens Opportunities for Manufacturers to Try on Advanced Apparel Manufacturing Technology
- Increase Productivity with Versatility -Use Computer Operated Sewing Machines
- Joint Robotic Projects Proposed
- R&D Strives to Meet the Change of Quick Response
- AAMTD - One of Three in the Country.
- Coat Manufacturing Methods to be Revised
- Issues Regarding UPS to be Addressed
- R&D Objectives - More than the Objective

Over 2,000 copies are mailed to the industry each quarter and we have received numerous positive comments.

In addition to the newsletter three promotional videotapes were produced, one early in the project (1989) which was distributed to hundreds of apparel firms and two very recently to promote the Quick Response/EDI center.

Several articles were written by the AAMTD for Bobbin and Apparel Industry magazines about the activities and research at F.I.T. Also, publicity for the AAMTD appeared in the following publications:

Accessories
Army/Navy Retailer
Apparel Industry Magazine
Bobbin
Chain Store Age Executive
Children's Business
Crain's NY Business
Daily News Record

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Distribution
Echoes
EDI World
HFD
Home Fashions
Index
Kids Fashions
Knitting Times
Mass Market Retailers
Outerwear
Retail Information Systems News
Small World
Textile Chemist & Colorists
The Boston Globe
The Koch Report
The New York Times
The Provider (DPSC)
U.S. News & World Report
Women's Wear Daily

Besides numerous informal seminars with industry visitors there were several formal seminars held on such subjects as Flexible Manufacturing, Computerized Costing, and Gainsharing. Seminar and workshop activity never expanded, though, due to the lack of promotional resources and the scarcity of meeting facilities at F.I.T. In the last project year, however, regular two hour QR/EDI introductory seminars were held weekly in the QR/EDI center for small groups of people who responded to publicity items in some of the publications mentioned above. Larger and longer (one to two day) seminars are in the planning stages for QR/EDI but will not take place during the AAMTD contract.

d) Short Term R&D

During the six years of the F.I.T. AAMTD there were twelve main R&D projects ranging in subject from the design of military clothing to the robotic pressing of trousers. Many more R&D proposals were submitted to the DLA, some at their request, but never acted upon. Of the twelve main projects, several were broken down into sub-projects dealing with different aspects of the main project theme. The following are the descriptions and results of each project.

PROJECT NUMBER: DLA900-87-D-0016-0001

SUBJECT: Survey of Available Computer Software for Maintaining Work-in-Process and Quantifying Manufacturing Throughput Time.

MAJOR OBJECTIVE: Describe the findings of a survey of the apparel industry to determine available programs dealing with the subject matter; and, ascertain the system/s, if any, that are in practical use and describe those which allow utilization of computers in a more universal, rapid and effective manner.

PROJECT TERM: November 1, 1988 to December 31, 1990.

PROGRESS SUMMARY: Forty-one companies were contacted and interviewed to obtain a software package which would predict manufacturing throughput time and adjust the prediction according to the efficiency history of workers assigned to specific job tasks involved in the production of specific garment styles. It was also hoped that the package would indicate the quantity of work that is required at each worker's work station predicated on the efficiency history of each worker assigned to specific job tasks involved in the production of specific garment styles. All software developers/vendors queried indicated that their software did not provide the desired information; but there was an apparent need for the information and it would be valuable for management to have. All software developers/vendors, with only one exception, indicated that, on condition that should they be given a contract to develop this software, they could do so. The one exception however, understanding the importance of this software to Quick Response planning (and its marketing significance), began the software development but was unable to complete the project before discontinuing its business.

Originally, this project anticipated to find and test the appropriate software. Since the appropriate software did not exist, we were unable to complete this project. It was, therefore, necessary to terminate the project.

Project was terminated. Final report of March 31, 1991 was distributed July 1, 1991.

PRINCIPAL INVESTIGATOR: Irwin Kahn; Dean, Business and Technology Division; Fashion Institute of Technology.

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PROJECT NUMBER: DLA900-87-D-0016-0002

SUBJECT: Development of a Comprehensive Supervisor Training Program for Advanced Apparel Manufacturing Technology.

MAJOR OBJECTIVES: Increase the use of advanced apparel manufacturing technologies by 1) locating and evaluating supervisory training programs which provide information on the utilization of AAMTD as may exist; and, by creating and field testing a comprehensive AAMTD supervisory training program for use in the industry.

PROJECT TERM: December 21, 1988 to July 31, 1990.

PROGRESS SUMMARY: A survey was made of 747 companies, of which 32 responded. Of these, 11 had training programs. Analysis showed that most training was superficial regardless of whether it was of limited frequency or continuing, in-house or out-of-house, because most departing supervisors are replaced by experienced outsiders. It was evident that a new program must address multi-cultural issues, group dynamics and motivational techniques, quality standards, training targeted to size of business, and the cost of pre-training supervisors.

A decision was made to produce a coordinated set of videos which would be flexible and meet the project goals.

Brooks Brothers was selected as the test site for the training materials.

A management consultant, Emanuel Weintraub Associates, assisted the project team in drafting a ten-segment video program which a commercial video production firm produced.

The project has been completed. Final Report and complete sets of the ten-segment video program have been forwarded, as of August 20, 1991 to both DLA and DPSC for review and further instructions.

A follow-on project proposal was been submitted.

PRINCIPAL INVESTIGATOR: Howard Korchin; Professor, Apparel Production Management Department, Fashion Institute of Technology.

PROJECT NUMBER: DLA900-87-D-0016-0003

SUBJECT: Comparison of Cost and Production Data Between a Traditional Bundle System and a Unit Production System Installation.

MAJOR OBJECTIVE: Analyze the impacts of new Unit Production System installation (UPS), on production costs, etc.

PROJECT TERM: August 9, 1989 to November 30, 1991.

PROGRESS SUMMARY: The analysis technique for comparing transition data on costs and payback was chosen and the site, Ippoliti, Inc., which was having a new Eton system installed, was chosen.

Data was collected on baseline conditions by site visits and use of the computerized data systems in the plant. However, due to the incompleteness of the manufacturer's data the project suffered a 8-10 week setback.

Data was, however, analyzed and a Phase I report issued.

Phase II, the installation of the UPS equipment was seriously delayed by unanticipated plant physical problems. The start-up of the new lines was finally started September 4, 1990 and the collection and analysis of new data was begun. The results of these analyses show that output increased 9.6%, production time per unit decreased 17.3%, average production cost per unit decreased 12.3%, and the number of assembly department workers decreased 27%.

The project has been completed and the Final Report submitted to the DLA.

PRINCIPAL INVESTIGATOR: Josef Korngruen; Professor, Apparel Production Management Department, Fashion Institute of Technology.

PROJECT NUMBER: DLA900-87-D-0016-0003

SUBJECT: Comparison of Cost and Production Data Between a Traditional Bundle System (TBS) and Modular Manufacturing Systems (MMS).

MAJOR OBJECTIVES: Provide comparative data on costs and changes in the subject production systems by doing case study analyses of companies in transition from TBS to MMS.

PROJECT TERM: January 2, 1990 to November 30, 1991.

PROGRESS SUMMARY: Two firms were selected for observation as they made the transition from TBS to MMS. Site visits were made by the Project Leader and student evaluators. Data was gathered by in-plant interviews with management and workers, computerized process data systems, and time studies.

After observing the firms and studying the costs and benefits of them both, it is evident that MMS is a viable management strategy. Some significant points discovered are:

- * MMS requires total management commitment.
- * MMS significantly reduces work in process.
- * MMS improves quality.
- * Operators earnings have the potential to increase.
- * Pressure on management and floor supervisors increases. More decisions have to be made more often.
- * The role of the supervisor becomes more complex.
- * The best module size appears to be 3.5 operators working together.
- * Complex garments can be produced in a modular environment utilizing multiple modules.

- * Group incentives are important to operator acceptance of working in a module and achieving desired productivity goals.
- * MMS encourages self initiative and job enlargement in the work place.

In both cases studied the return on investment analysis for the conversion was bypassed in favor of non-traditional payback analyses.

The project has been completed and the Final Report submitted to the DLA.

PRINCIPAL INVESTIGATOR:

Aaron Schorr; Professor, Apparel Production Management Department, Fashion Institute of Technology.

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PROJECT NUMBER: DLA900-87-D-0016-0003

SUBJECT: Installation of Modular (Carousel) Sewing Station.

MAJOR OBJECTIVE: Obtain and incorporate a Kansai Special three-station carousel modular manufacturing unit into a unit production system.

PROJECT TERM: April 24, 1991 to November 30, 1991.

PROGRESS SUMMARY: Delivery of the Kansai unit was accomplished in late October, 1991. Set-up and installation was very difficult requiring major modifications of the sewing machine drive systems. The system was operational by November 30, 1991 and an evaluation report was written. The main results were that the system saved floor space and time but caused operator fatigue because of its required stand up operation. Also, the safety of the system had to be improved as there were a considerable number of protruding devices which had considerable rotational force behind them.

PRINCIPAL INVESTIGATOR: Josef Korngruen; Professor, Apparel Production Management Department, Fashion Institute of Technology.

Aaron Schorr, Professor, Apparel Production Management Department, Fashion Institute of Technology.

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PROJECT NUMBER:

DLA900-87-D-0016-0004

SUBJECT:

Improved Manufacturing Methods for Navy Peacoats.

MAJOR
OBJECTIVES:

Revise manufacturing methods to conform to advanced manufacturing systems; b) Evaluate and recommend suitable, readily available garment components; and determine the possibility and extent of a reduction in the total number of garment sizes to be inventoried.

PROJECT TERM:

August 9, 1989 to October 1, 1991.

PROGRESS SUMMARY:

Size tariffs were analyzed and a 28% reduction was recommended. Modifications to the epaulet (Women's coat only) allow unisex coats to be made, with further savings. Replacements for interior fabric components were investigated and recommendations were made which can culminate in manufacturing and cost improvements.

Prototype unisex coats were produced and submitted for Navy approval. Data was gathered on alterations at time of issuance, and fabric yields and costs were calculated. Upon receiving Navy approval production of the full size range was completed and delivered. Computer tapes of all graded patterns were also produced and delivered along with other necessary and important data.

Procurement cost savings of up to \$350,000 per year are possible with manufacturing procedures detailed.

The project was completed and all samples, pattern tapes, etc. were delivered. The final report dated September 30, 1991, has been distributed.

PRINCIPAL
INVESTIGATOR:

Josef Korngruen; Professor, Apparel Production Management Department, Fashion Institute of Technology.

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PROJECT NUMBER: DLA900-87-D-0016-0005

SUBJECT: Developing Patterns and Clothing Prototypes for Navy Women's Dress Uniforms.

MAJOR OBJECTIVES: Develop and grade new patterns and prepare and fit test garment prototypes for five items of Navy women's dress uniforms using recently established anthropometric data and advanced apparel manufacturing technologies.

PROJECT TERM: August 25, 1989 to April 15, 1991.

PROGRESS SUMMARY: Multifaceted analyses of the dimensions, components, and manufacturing technologies were conducted on the five women's dress uniform parts. New model forms were constructed based on the new anthropometric data provided and patterns were developed. Inherent in these efforts were the needs to improve the fit of these uniform components, modify the construction to permit easier and less costly alterations when necessary, and make the garments capable of being mass produced by advanced technology methods.

Prototypes were created and submitted; modifications were requested by NCTR and carried out; and, sample garments were resubmitted. Upon approval, patterns were digitized, where upon NCTR requested design changes outside the contract scope and project progress was curtailed until these problems were worked out and the new FIT designs were accepted.

Prototypes of the five garments were completed and trial fittings of both new-style FIT garments and NCTR-made garments were conducted at the Naval Training Center/Orlando, Fl. Initial and unofficial results indicate that the FIT garments were preferred for all cases except the dress coat. Also, the new sizing system appears to eliminate the need for any major alterations.

All objectives were accomplished without changing the current design or appearance of the garments.

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The project was completed and all samples, pattern tapes, manufacturing sequence charts, etc. were delivered. The final report, dated March 19, 1991, has been distributed.

**PRINCIPAL
INVESTIGATOR:**

Hilde Jaffe; Professor, Fashion Design-
Apparel Department, Fashion Institute of
Technology.

PROJECT NUMBER: DLA900-87-D-0016-0006

SUBJECT: Automated Handling of Garments for Pressing,
Phase I.

MAJOR OBJECTIVES: Develop and demonstrate an intelligent
automated pressing system which loads a
complete garment or subassembly onto a form
and smoothes it for pressing. Advance the
state of the art and integrate mathematical
modeling of limp fabrics, sensing of fabric
position and condition; and automated handling
of garments into the system.

PROJECT TERM: November 6, 1989 to September 30, 1991.

PROGRESS SUMMARY: Hardware for the robot cell was acquired and
sensing hardware and several forms of software
were developed. Sensors for seam tracking
were developed and tested, and software
subroutines were integrated into the whole
system as appropriate. Grasping mechanisms
and seam alignment devices were also developed
and tested as were wrinkle sweeping
appliances.

Fabric samples were acquired and made into
trousers, for test in the robot cell at
Rensselaer Polytechnic Institute. The press
prototype gripper, and ancillary systems were
installed. Upon full scale testing and
demonstration exceptionally satisfactory
results were obtained.

Major effort went into software to model
fabric motion in three dimensions and to
provide good graphical interfaces between man
and machine.

The project as contracted, was completed and
the Final Report was on November 15, 1991.

A proposal to continue the work was submitted
for approval but was rejected as being too
ambitious. A scaled-down proposal, which
eliminates the cloth modeling work and which
concentrates on the refinement/
commercialization aspects of the system, was
also submitted without DLA response.

PRINCIPAL INVESTIGATOR: Aaron Schorr; Professor, Apparel Production
Management Department, Fashion Institute of
Technology.

PROJECT NUMBER: DLA900-87-D-0016-0007

SUBJECT: Senior Project: Analysis and Improvement of Existing Apparel Technology.

MAJOR OBJECTIVES: Investigate why, in some cases, the installation of new apparel manufacturing technologies does not meet expectations; and develop methodologies that will correctly assess the transfer of new technologies so as to insure that their performance meets expectations.

To as great an extent as possible, students were involved in this project in a full-scale hands-on manner.

PROJECT TERM: November 30, 1989 to October 15, 1991.

PROGRESS SUMMARY: Following manufacturer interviews and data analyses, the selection of apparel manufacturing technologies for investigation were narrowed to three cases: auto jig, J-stitch, and cabinet shirt press installations at three different plants.

After repeated site visits, observations, and interviews, case study reports were written and submitted for comment to machine vendors, users, and others.

Data was collected for analysis of the technology change process and an improved technology transfer system was developed.

Conclusions were, in the case of the autojig, that there are no problems in the mechanics of the installation studied but rather in the application of the system to a production plan that does not permit an advantageous work flow. In the case of the J-stitch machine, better utilization of the system can be achieved when adequate and proper operator training methods are employed. Finally, in the case of the cabinet shirt press, system improvements can be achieved by modifications made to the equipment, but even better results would be possible by redesigning the system.

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A feasibility model and a checklist for evaluating equipment and systems were developed for use by apparel manufacturers prior to the purchase and installation of new technologies or methodologies.

The project was completed and the Final Report was distributed on November 30, 1991.

**PRINCIPAL
INVESTIGATOR:**

Aaron Schorr; Professor, Apparel Production Management Department, Fashion Institute of Technology.

PROJECT NUMBER:

DLA900-87-D-0016-0008

SUBJECT:

Develop a Business Plan.

MAJOR
OBJECTIVES:

Collect information that can later be used to develop a plan that will continue the operation of the facility after DLA funding of AAMTD/FIT operations terminates in order to assure perpetuation of the facility's operations.

PROJECT TERM:

January 10, 1990 to October 31, 1991.

PROGRESS SUMMARY:

Surveys and analyses have been performed to determine existing and future markets for facility services. Decisions regarding the best F.I.T./AAMTD mission have been made.

Using a standard business plan format interval and external variables have been identified, critical assumptions have been made, and major strengths and weaknesses have been enumerated.

All findings have been researched and examined and prepared for publication.

The project was completed and the final report was distributed on December 15, 1991.

PRINCIPAL
INVESTIGATOR:

Elaine Stone; Professor, Fashion Buying and Merchandising Department, Fashion Institute of Technology.

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PROJECT NUMBER: DLA900-87-D-0016-0009/1

SUBJECT: Design for Manufacturing and Assembly in Apparel.

MAJOR OBJECTIVES/S: Develop a handbook detailing system whereby garments can be designed for maximum manufacturing efficiency with minimal sacrifice of designer initiative. The handbook focused on dress skirt production using advanced manufacturing techniques as much as possible.

PROJECT TERM: May 17, 1990 to January 15, 1992.

PROGRESS SUMMARY: A 173 page handbook containing over 500 illustrations has been developed. Preproduction samples have been distributed for comment and expert opinions.

All comments received have been laudatory. Reviews were completed any necessary changes were made. The Final Report and sample copies were distributed to NCTR, USANR, and the DLA.

100 copies of the completed book were printed and await DLA disposition direction.

PRINCIPAL INVESTIGATOR: Debbie Gioello; Professor, Fashion Design Apparel Department, Fashion Institute of Technology.

PROJECT NUMBER: DLA900-87-D-0016-0009/3

SUBJECT: Implementation of a Constraint Based Design and Grading System - Phase I

MAJOR OBJECTIVE: To implement the technology developed by 3M company for a new state-of-the-art pattern design, grading, and marking system. Working with Gerber Garment Technology, FIT would manage the implementation and ultimate commercialization of the 3M technology for application to military service apparel to:

- Improved specifications for garments;
- Improved fit of garments;
- Quick response to changing anthropometric measurements of service personnel;
- Reduced costs for development of new patterns;
- A practical technology for custom-fit uniforms;
- Easier integration with other computer systems within the military services complex;
- A database based on commercial 4th generation relational database technology (4GL) that will allow for extensibility and customization to meet the needs of specific users; and,
- Packaging of system features that will allow for a concept called the "total garment package" which would be useful in automatically generating the manufacturing specifications for a particular garment style. This package will contain all the necessary costing, cutting, assembling and distribution information normally needed by a contractor or sub-contractor in order to bid on a military garment contract, or the complete specifications needed to manufacture and deliver the garment.

Similar benefits and substantial savings will also accrue to the commercial apparel manufacturing industry.

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The project was intended to be completed in five phases: Phase 1; Phase 2A; Phase 2B; Phase 3A; and Phase 3B. Each phase would theoretically last approximately seven months with an overlap of about one month between phases. This would result in a total overall project plan of between 2.5 and 3.0 years.

Phase 1 objectives analyze the 3M technology, train computer personnel on its use, re-write the basic software for use on contemporary platforms, develop system design specifications, development strategies and database linkages, and demonstrate the constraint based principles to the DLA.

PROJECT TERM:

March 9, 1992 to April 21, 1993

PROGRESS SUMMARY:

The completion of Phase 1 included:

- Transferring the hardware, software and documentation from 3M;
- Porting the 3M constraint engine technology to a Gerber Garment Technology, Inc grading/marketing system platform;
- Adding a digitizing front end to the 3M technology;
- Achieving global definition of the implementation strategies; and,
- Developing specifications for the system's garment specification sheet, piecegoods database and browser functionality.

An interim final report was submitted to the DLA on August 19, 1993.

PRINCIPAL INVESTIGATOR:

Debbie Gioello, Professor, Fashion Design Apparel Department, Fashion Institute of Technology

PROJECT NUMBER: DLA900-87-D-0016-0010

SUBJECT: Military Dress Coat Alignment Problem.

MAJOR OBJECTIVES: Investigate the causes of alignment problems in the fabrication and inspection of military dress coats and recommend feasible solutions to the problems.

PROJECT TERM: April 25, 1990 to September 30, 1991.

PROGRESS SUMMARY: Site visits were made to DPSC supply centers and dress coat manufacturer's facilities to examine garments, assembly processes, patterns and Quality Assurance procedures, and to interview personnel.

Military patterns, checklists, standards, and specifications were examined for impact on QA problems. Many problems, including inspection tools, mannequin variations, inspection methods, specifications, and inspector training were all found to contribute to the observed problems.

Short term, medium range, and long term recommendations to alleviate the problems were formulated and presented.

The project has been completed, recommendations have been submitted. The Final Report was completed and distributed on November 30, 1991.

A follow-on project proposal was submitted to implement the findings but never acted upon by the DLA.

PRINCIPAL INVESTIGATOR: Saul Smilowitz; Professor, Apparel Production Management Department, Fashion Institute of Technology.

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PROJECT NUMBER: DLA900-87-D-0016-0011

SUBJECT: Research for Women's Army Dress Skirt and Slacks.

MAJOR OBJECTIVE: Produce experimental prototypes of skirts and slacks in strict accordance with modified specifications. Make recommendations for improvement, if any. Produce additional prototypes which incorporates any approved changes.

PROJECT TERM: March 11, 1991 to March 31, 1992.

PROGRESS SUMMARY: An initial set of prototypes were produced and recommendations for improvement were made to USANR. A pilot run of garments was then made incorporating the approved recommendations and submitted to the Army for evaluation.

PRINCIPAL INVESTIGATOR: Josef Korngruen; Professor, Apparel Production Management Department, Fashion Institute of Technology.

PROJECT NUMBER: DLA900-87-D-0016-0012

SUBJECT: Space Facility Emergency Response Ensemble (SFERE)

MAJOR OBJECTIVE: Develop a new, advanced protective clothing ensemble for military personnel working in hazardous environments such as rocket fuel fires.

PROJECT TERM: July 2, 1993 to September 1, 1995

PROGRESS SUMMARY: Two of the three protective clothing units have been designed: the fire retardant inner garment, or coverall; and the central chemical resistant garment. No work has yet been initiated on the outer garment.

After creating a series of trial samples a first prototype of the coverall has been prepared which has been approved by the COTR with only a few minor modifications. It is ready to be converted into a final prototype for field trial evaluations as soon as the selected fabric becomes available.

A pre-prototype sample of the central chemical resistant garment has been approved for design by the COTR. Construction of a first prototype of it for evaluation and approval prior to field trials is ready to begin.

We were informed by the COTR that, effective January 31, 1994, the project will be put "on hold" for an indefinite period of time due to problems with contracting out the helmet and breathing pack, funding cuts, and take-backs.

PRINCIPAL INVESTIGATOR: Debbie Gioello, Professor, Fashion Design - Apparel Department, Fashion Institute of Technology.

IV. Benefits of the Program

Although, as stated above, the volume of use of the demonstration site by domestic garment manufacturers was disappointing, there were some notable benefits to the DLA, the industry, and to several educational institutions. These benefits are difficult to quantify but are nevertheless real and time will tell how they affect the long term aspects of the sewn product industries.

a) Benefits to the Department of Defense

The principal benefits to the DoD come from the results of several R&D projects which produced new cost effective designs for military clothing. The re-design of the Navy women's uniforms will substantially reduced alteration and manufacturing costs due to the better fit and manufacturability. Similarly, the re-designed Navy pea coat allows a large reduction in size tariffs which will reduce inventory costs. Also, the peacoat material costs and production operations were significantly reduced which will save over \$350,000 per year in purchase costs.

The project which compared progressive bundle manufacturing and Unit Production at a dress coat military contractor showed such great savings that other contractors (and commercial manufacturers) will be encouraged to purchase this equipment to keep costs down. Also, the project which investigated the causes of high rejection rates of Marine dress coats clearly indicated that substantial inspection costs could be eliminated if the specification and inspection instrumentation were improved and made less ambiguous.

Significant benefits to the DoD came out of the demonstration site activities as well. Numerous suggestions were made to the Army and Navy clothing R&D facilities as a result of our working with their designs and some were readily adopted (See section III-Results). The DoD undoubtedly received the most direct benefit of the F.I.T. AAMTD efforts.

b) Benefits for Manufacturers

The main benefit obtained by sewn product manufacturers was the awareness that the advanced technology equipment which they had read about was real and viable. Numerous skeptical visitors left the facility with a different opinion of Unit Production Systems, computerized cutters, CAD systems, and other automatic equipment. It is not known how much of this positive influence resulted in the purchase of new equipment but some major psychological hurdles to applying technology were surely overcome here.

Also, because of our later work with The Government Contractors Advisory Committee, a number of the firms became aware of Total Quality Management, ISO9000, Quick Response, Electronic Data Interchange, Product Data Management, and other new management techniques of which they either had great misconceptions or total ignorance. It will take time but this certainly will have an influence on these firms ultimately pursuing and adopting some or all of these methods.

c) Benefits to Equipment and Systems Suppliers

The main benefits to suppliers was that of a free showroom in New York City where potential customers could see their advanced technology equipment in action. Surprisingly only a few took advantage of this, bringing customers in for demonstrations. Again, no hard data exists showing how many systems were sold as a result of this but we believe we were instrumental in the sale of NC cutters, CAD systems, UPS systems, and programmable sewing machines.

Another benefit to the suppliers was one of testing and evaluation. As the AAMTD actually operated the equipment in a quasi-production basis, and our staff was technically oriented, we could provide a rational evaluation of new equipment which is usually lacking in a customer to vendor field relationship. The AAMTD provided detailed critiques of the following products, most resulting in modifications being made to better suit the applications.

AMF Buff Pocket Setter
AMF Autojig
Union Special Fly Topstitcher
Kansai Carousel
Juki 320 Programmable Sewing Machine
Brother Excedra Programmable Sewing Machine
EFKA Programmable Drive System
Singer 591P Programmable Sewing Machine
AMF Pin Tuck Machine
Mitsubishi Programmable Sewing Machine
Merchant Data Solutions POS Software System
Accounting Wiz Manufacturing Software System
MIM Programmable Pocket Hanger
GGT 2001 NC Cutter

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d) Benefits to Educational Institutions

The F.I.T. AAMTD not only had a positive effect on the Fashion Institute of Technology but on several other institutions as well. And, although the AAMTD facility never became an integral part of the F.I.T. curriculum, it nevertheless allowed students here to become aware of the advanced technology that was being adopted in the industry in which they will be working. Numerous lecture tours were given to students from all areas of the school. The majority of them were given to the Production Management, Fashion Buying and Merchandising, and Fashion Design majors. In a few cases, instructors in the Production Management Department utilized the demonstration site for class projects but this was sporadic. Nonetheless, these activities gave the students a technology viewpoint quite different from that available in the New York City "sweatshop" environment.

Another benefit to F.I.T. was a complete upgrade of its sewing technology laboratory. Prior to the establishment of the AAMTD the production laboratory was a collection of ancient and specialized equipment gleaned, for the most part, from the obsolete throw aways of equipment vendors. As the AAMTD plans developed, the new director established a policy of only allowing equipment in the facility which was in the currently sold product line. This eliminated the customary practice of giving schools the remaining old stock in the warehouse of canceled products. The result was a new laboratory which was the most complete and technologically advanced in the northern United States. And, not only was the laboratory upgraded but some faculty members, as well as students who worked in the AAMTD and on R&D projects, were able to upgrade their expertise.

During its 6 year term, the F.I.T. AAMTD developed working relationships with Rensselaer Polytechnic Institute (RPI), Cornell University, and the New Jersey Institute of Technology (NJIT). Cornell had some esoteric computer aided apparel design capability but no apparel production expertise. RPI and NJIT were totally unaware of the workings of the sewn product industries.

During our work on the automatic pressing project, the F.I.T. AAMTD personnel spent considerable time acquainting RPI faculty members with the industry. After the project development was well underway, these scientists and engineers were becoming very interested in seeking solutions for many of the challenging technical problems facing garment manufacturers. This is evidenced by the fact that, even several years after the pressing project was canceled by the DLA, RPI is still interested in seeking development projects in this industry.

Similarly, Cornell and NJIT became acquainted with the business and technical challenges of the apparel industry through the F.I.T. AAMTD. In the case of Cornell, the Department of Human Ecology sought to develop a joint New York State extension service and industry technology needs analysis project with the AAMTD and during this process their faculty became quite aware of the details of apparel production. NJIT, with the help of the AAMTD, actually obtained a NIST project for New Jersey to improve the sewn products business there and designated F.I.T. as its apparel resource.

Therefore, there are a lot more first rate scientific and engineering minds aware of and interested in the apparel industry than there were before the F.I.T. AAMTD. It is hoped that this will someday prove beneficial to domestic apparel manufacture.

V. Lessons Learned from the Project

There were many, many lessons to be learned from the six year AAMTD exercise, some positive and some negative. To list all would take a publication of a daily log. Trying to approach the industry with the message of advanced technology was very new to F.I.T., the DLA, and the many apparel companies. An almost yearly change of course was also taken by the DLA. Resource constraints were severe but, all in all, the exercise taught that an AAMTD is relatively easy to establish. Getting the horse to drink, though, is another matter.

The following are some of the major lessons learned in the establishment and operation of the facility.

a) Equipment and Software Suppliers Response

It became quite evident early in the project that the suppliers interest in supporting the activity was very high when prospective sales were seen but waned rapidly as direct sales did not ensue to either the school or visitors. As support takes sales people's potential selling time this was quite understandable.

Also, we were told several times by suppliers that a collection of machinery and software was not considered and inducement to participate by progressive garment manufacturers. More interest would be generated for suppliers and users if seminars, etc would be held on manufacturing methods, production control, quality improvement, EDI implementation, CAD implementation, etc. Looking at the relative success of the three AAMTD schools this seems true.

b) Garment Manufacturers Response

The New York area garment manufacturer will not partake of something like the AAMTD demonstration without a clear believable profit incentive. Most of them saw the AAMTD as a theoretical exercise but not practically applicable in the local industry of small businesses. An impression of overwhelming capital costs, training, and maintenance requirements which they had was virtually impossible to overcome in the typical short demonstrations that were held. The AAMTD "factory", in order to positively impress the regional audience, should be of a lower technical level and a higher operational level geared to women's blouses, dresses, sportswear, etc. Of course this market was not compatible with the DLA's requirement of dress clothing and uniform focus.

The few visitors from the rest of the U.S. did not usually have these psychological impediments but either already used much of the technology and/or worked directly with the suppliers.

c) Institutional Response

The limited use of the AAMTD by the F.I.T. faculty was puzzling. Although it does take several years to adopt new items into the curriculum, virtually no formal use of the AAMTD was scheduled during the six year contract. F.I.T. was very proud of the facility using it as a showcase for visitors, etc. but it seemed to be unable to find a way to elicit direct student and faculty participation in the demonstration activities. This seemed to be because of the fact that F.I.T. is neither a research oriented nor a major graduate school. Faculty and student incentives are mostly in other directions than spending the effort to master new technology.

The institutional response to the R&D projects was somewhat better than that of the demonstration site. This was obviously because the R&D projects had direct remuneration for the faculty, although at rates which barely competed with what they could bill outside consulting clients. The lesson learned is that the institution must make an operation such as the AAMTD as financially attractive to the faculty as other functions which they perform or assign AAMTD hours as part of their normal duties.

d) DLA Response

The DLA response for the first three years was great, reinforced by a very constant dialogue about needs and resources. The Contracting Officers Technical Representative (COTR) provided the right and only leadership. However, after DPSC assumed the contract administration it was nearly impossible to determine who administered the project. (See II - Objectives above). DPSC's direction usually took the form of a direct or pocket veto and the COTR's guarded direction seemed easily overruled by DPSC. During the last 3 years numerous mixed signals were given to F.I.T. and vague RFP's were issued. F.I.T.'s proposals, whether solicited or unsolicited, were rarely acknowledged or responded to. This all culminated in the DPSC ordered six month long audit which resulted in no significant revelations and destroyed the momentum of the project.

The response of Navy and Army R&D at Natick, however, was very good. Our work for them was always praised and, in the case of the Navy, resulted in more requests for design work. In these negotiations, though, there was a clearly identified person in control of the projects, his or her funding merely flowing through DPSC to us.

For projects such as the AAMTD to succeed and be effective only one government office should be in full charge.

e) Demonstration Site Production

The site lacked reality even after it was put on a two day per week schedule. Starting it up on Tuesday and stopping it on Wednesday never gave it a chance to run efficiently. Also, operators who would take this part time work were not skilled nor did they have the proper incentives. They never developed teamwork or acceptable productivity. If the facility is to be perceived by the industry as real, it must be real, ie - full 5 day per week operation with delivery dates and customers.

f) Economic Justification

Computer based payback analyses for return on investment, net present value, return on capital employed, etc. are useful for large firms, even with so-called intangibles such as improved quality, lower labor turnover, etc. However, the large corporations believe that they have ample expertise in this area and don't need an AAMTD. But the small to mid sized company needs

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something very simple (simple payback?) to convince it that new equipment or methods will be profitable. The emphasis of economic justification should be on rough but quick estimates which are easily understood by those of purchasing authority.

Also, even after we were able to convince some firms that the equipment would have a positive financial effect, the lack of available capital to these same firms usually discouraged them from making any large purchase. Clearly, they needed assistance in finding ways to pay for the acquisition of new technology.

g) Mixing Military Goals with Commercial Ones

The industry, and even some parts of F.I.T., developed a perception that, since the DoD was funding the project, only those doing military work could participate. In spite of many efforts to dispel this it strongly persisted. And, since most of the NY area's apparel business is in women's fashions, many people were discouraged from even inquiring about the facility. This was originally caused by much early publicity with headlines such as "F.I.T. Setting up Advanced Tech Center for Military Uniforms" (DNR - 10/28/87).

If a facility or service wishes to attract commercial clients it should scrupulously avoid being principally aligned with military organizations.

h) Dissemination of Information

The F.I.T. AMIS newsletter worked very well. Over 2000 were mailed each quarter and generated considerable interest in R&D reports and equipment evaluation. Numerous good industry contacts were made by this publication. The format was generally held to four pages of easy to read text with some photographs. This effort should continue as long as the AAMTD (Now QR/EDI Center) exists.

Although many copies of research reports were sent to requestors the most sought after AAMTD results were that of the videotape set produced for the project titled "Development of Comprehensive Supervisor Training Program...". These tapes, each addressing a particular aspect of supervision, were offered at \$750/set (our cost) and over 35 sets were sold. However, sales plummeted as soon as the intensive and expensive telemarketing effort stopped. It seems that colleges are not very good at marketing products and this program should have been turned over to a commercial firm.

i) Quick Response/Electronic Data Interchange

This later (last year) effort at the AAMTD was the most rewarding as far as supplier and user response was concerned. The demand for assistance by small and mid sized of all types (retail, manufacturing, shipping, etc.) from many industries is large and growing and cannot be met by any one vendor of a piece of it. This is mostly recognized by the software vendors who are eager to get their product into the demonstration. Also, the visitors list grows daily with a considerable backlog. Small firms are learning that customers require this and are therefore driven to learn and apply it. EDI seems to be the best way to introduce technology into the small company segment of the industry and, as it will demand quicker manufacturing response, the need for acquiring improved manufacturing technology will develop rapidly.

The above comments are, of course, the opinion of the writer and may differ in focus and magnitude for other participants and observers. To get the clearest viewpoint and the most value out of any critique Total Quality Management principles such as results analysis should be applied in a lengthy brainstorming meeting of the principal players. Without this type of post mortem any future AAMTD type programs will be doomed, in large part, to repeat history.

VI. Suggestions for Future Activities and Research

The following suggestions fall into two categories. The first are intended to assist the DLA in improving the effectiveness of future AAMTD type projects. The second are those which F.I.T. may use in planning and continuing the existing operation.

1. Activity Suggestions to the DLA

a) Adhere to the original contract direction for its duration. Changing the focus (ie - commercial to commercial/military to solely military to dual use) never allowed the AAMTD to develop a strong and concentrated resource base.

b) Have many more informed contract reviews where progress, deficiencies, resources, etc. can be openly discussed. Annual contract briefings are necessary but rarely structured to elicit continuing dialogue between the contractor and the DLA (or whomever else is in charge). More constant course corrections would have avoided many misunderstandings and performance criticisms.

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- c) Establish one and only one relatively long term authority for controlling the contract, both technically and administratively. The dual and sometimes conflicting authorities involved in the AAMTD and the constantly changing management of one of those authorities (DPSC) should be avoided. Too much effort was spent on finding out who was in charge in order to meet goals than was necessary.
- d) Tailor the demonstration or training facility to the local geographic area or place it in an area which has pertinent resources. The New York City area does not have a concentration of dress clothes manufacturers so establishing a dress clothing resource was difficult. However, the local area does have a high concentration of firms which control the whole clothing pipeline and they are driving the establishment of Quick Response and Electronic Data Interchange (Electronic Commerce) facilities here.
- e) The DLA should poll military and potential military contractors before establishing any future SOW's for apparel endeavors. Most times the contractors' needs were quite different than the AAMTD's SOW and, by the time the DLA asked the AAMA Government Contractors Committee to advise them it was too late. They thought they were left out.
- f) AAMTD type projects should be administered as research instead of as a contracted supplier of goods and services. The myriad of paperwork, including quality control forms, which are normally required of manufacturers are counterproductive and expensive.
- g) The response to proposals must be vastly improved. Early R&D proposals were accepted or rejected within a few weeks. By the third year, however, a two year or more delay was not uncommon even for a denial. Many times the researchers and industrial partners were no longer available or interested when a project (or phase of a project) was approved and it had to be re-cast to meet the goals.
- h) Written reasons for proposal rejections should be prepared by the DLA and discussed with the contractor. This process would make the contractor much more aware of the needs of the DLA and able to respond more directly instead of guessing.

- i) Audits should not be used as a harassment weapon against a contractor without the COTR's initiation citing specific performance deficiencies. This institution almost completely lost the ability to complete the contract properly due to the six months duration of an audit and the cessation of funding during the period. Funding should have continued and any audit deficiencies resolved later (they were minuscule in the case of F.I.T.'s AAMTD).
- j) The DLA must fund, at least for start-up purposes, outreach consulting for present and potential military contractors. The prevention of this activity by DPSC was a great impediment in interesting contractors in applying advanced technology. To establish the demonstration center and then tell the contractors that we couldn't assist them at their factories was, in large part, the reason the contractors never took the AAMTD program seriously.
- k) The DLA should continue the activities in the advancement of dual-use technology, ie - improving commercial manufacturers and military clothing designs to allow both military and civilian garment production in single facilities. This is the only way in which the DLA can reduce its dependency on the present low technology, low productivity, and sometimes quite unstable and unreliable military contractor community.

2. Activity suggestions for F.I.T.

- a) F.I.T., in pursuing future projects with the DLA or other Government entities, should regard the Government more as an important customer than a "grantor". It should be given the same front office attention as any large influential corporation would during visits, meetings, and requests for information. This is because, of the few times the DLA did try to establish dialogue with the F.I.T. management, it met with apparent indifference. More dialogue and more research work may have developed if the institution opened higher level lines of communication with the DLA.
- b) F.I.T. should have better definition of its needs and goals when obtaining a contract such as the AAMTD. The only five year plan which the institution had concerning the AAMTD was to carry out the contract provisions as best as possible. Thus at the end of the contract there was no co-existing program to assume the function of the AAMTD and a great amount of difficulties are being experienced in continuing the operation.

c) F.I.T. should, in all future programs instituted by substantial government contracts and grants, have definite plans to integrate these programs into the curriculum as much as possible. In fact, if the curriculum needs of the school are known, government requests for proposals (RFP's) can be sought after and evaluated on the basis of how they meet those needs. This will greatly increase the likelihood of the continued availability of the resources after the contract or grant term.

d) F.I.T. must assign faculty members to specific responsibilities in government research and other type contracts. The situation under the AAMTD where the program management had to convince faculty members to participate in the projects and then negotiate terms with them as outside consultants resulted in little feeling by administration, faculty, and students that the AAMTD was truly an institutionally sponsored program. The faculty in particular could see no ownership or institutional value in the operation. It was treated as just another outside client with obvious results.

e) The cost accounting functions for outside research projects such as the AAMTD, must be integrated within the normal F.I.T. accounting system. Too much administrative time and talent was spent in constructing and maintaining a totally separate (and manual) cost accounting system for the AAMTD which significantly reduced the time spent by the Director and his staff on technical project matters.

f) As the AAMTD was operated by F.I.T. as a completely off-line activity, with its own accounting, staff, and facility, it never quite lived up to its potential as it would if the total resources of the institution were behind it. Before F.I.T. enters into any similar major projects its management must make a conscious and serious decision regarding its intention to enter the academic research community. The appearance of being a research school without the commitment of schoolwide resources is soon seen by other research institutions as somewhat empty, thereby limiting the cross institution dialogue so necessary to become established as a serious research ally. If an institutionally sponsored program with resources to support inter college research networking is established (travel, professional memberships, meetings hosting, etc.) then F.I.T. should diligently pursue government research and outreach grants and contracts. Otherwise, the efforts needed to try and obtain such work and successfully carry it out would be better spent elsewhere.

3. Future Research Suggestions

In the course of the 6 years of AAMTD research work much information has been obtained regarding the needs of the domestic apparel manufacturing industry and, specifically, those of the military. Mostly these discovered needs have been addressed by F.I.T. in research proposals to the DLA, both solicited and unsolicited. Some of them were accepted by the DLA but a large number were not. F.I.T. AAMTD management still thinks that those not done are still vital to the improvement of competitiveness for the industry and the more efficient procurement of sewn products by the DLA. The following are brief descriptions of these research suggestions.

- a) Automatic Pattern Grading This was started under Phase I of the Implementation of a Constraint Based Design and Grading System funded by the DLA. As of this writing Phase II has not been approved (over 2 1/2 years in the approval process) and it seems that the DLA is not interested. However the results of this project would free the DLA (and other designers of volume produced clothing) from the time, inaccuracy, and skills limitations now causing severe bottlenecks in quickly bringing correctly fitting clothing to the recruits and markets. It is a vital part if the Demand Activated Manufacturing sought by NIST, DLA, and others is ever to be a reality. The potential cost and time savings for industry and Government are enormous.
- b) Applications of Total Quality Management Techniques to the DLA Garment Procurement System The DLA demands "zero Acceptable Quality Limits (AQL's)" from its contractor base, not really understanding what it means nor its impact on the procurement system. The F.I.T. proposed project to apply TQM to a cooperative team of DPSC and a contractor is absolutely necessary to determine how to do this and measure the results. It would become a model for the whole procurement system to follow to meet the DLA's goals.
- c) Alternate Finish Pressing Techniques Presently the greatest constraint to reducing the time and cost of producing inexpensive military dress clothing is the necessary operations in finish pressing. Mostly manual, and in severe environments, these operations require highly skilled and high cost laborers. As the manufacturing process becomes more and more efficient, the finish press function will become highly visible as a severe limit.

F.I.T., with Rensselaer Polytechnic Institute, started to explore ways to automate finish pressing. The DLA initially funded this research but withdrew funding after the exploratory phase. Nevertheless, there is still much work to do to find ways to drastically reduce the costs and skills presently required and only the proper research will accomplish this.

- d) Application of Quick Response Techniques to the Military Dress Clothing Procurement Process Although the F.I.T. submitted proposal to run an experimental Quick Response effort with DPSC and a cooperating contractor was never acknowledged or acted upon by the DLA, some similar project was recently awarded to one of the other AAMTD schools. This project should be expanded and encouraged as the long procurement time and its accompanying high cost are completely out of line with commercial practice. If the DLA is to ever achieve the "dual use" of commercial manufacturers to supply military dress garments, such a project is vitally necessary.
- e) Input Material Definition for the Effective Automation of Garment Manufacture The making of garments is probably the only mass production industry where the input materials have so little engineering definition. This has seriously limited the effective development of true automation since the machinery developers have to design for an unknown range of products characteristics and usually miss the mark. There are, however, newly emerging systems (FAST, etc.) which can quantify the properties of fabric so that it may be specified much as any other product construction material for appropriate quality control, machinery design parameters, and performance. This facility would greatly assist the machinery manufacturers and garment manufacturers in devising complete systems to reduce labor content and throughput time.
- f) Improvement of Dress Coat Inspection Procedures The F.I.T. project to analyze the reasons for the high reject rate of military dress coats clearly indicated the need for improvement in inspection techniques, garment specifications, and inspectors training. This work should be pursued by the DLA as it will have a short term result of significant savings for the Government and contractors.

g) Unification of Uniform Design Parameters for the Various Military Services During the F.I.T. AAMTD program there were numerous examples of slacks, skirts, dress coats, and trouser designs specified for each service (Army, Navy, Air Force, etc.) which differed not only in color and features, but in their construction details such as seam types, seam allowances, fullness, belt loop settings, etc.

In most cases these differences were arbitrary, reflecting the personal preference of the designer and not a conscious choice of the service which ordered them. This situation causes confusion for contractors and inspectors, the maintenance of completely different specifications, and in some cases the prevention of the use of automatic equipment. If, for example, the dress trousers for the Navy, Army and Air Force were made exactly alike except for the fabric and color very few service personnel would know the difference.

Therefore, DLA resources would be well spent in developing unified designs for as much dress clothing as possible, without sacrificing individual services features such as insignia, pocket flap shape, etc., to effect better control over patterns, sewing operations, and specifications. This could result in significant administration and manufacturing savings.

h) Application of Automation to Sewn Equipage The AAMTD schools have devoted their total efforts to addressing the clothing problems, both in design and manufacture. There are, however, a number of military items which are assembled in a similar manner as clothing. (web belts, equipment covers, tentage, bed clothes, etc.) It is a strong possibility that examination of these as regards specifications and manufacturing techniques would yield areas in which advanced technology could be advantageously applied.

i) The Effectiveness of Applying Advanced Technology - Case Studies The DLA/F.I.T. project which compared the productivity and costs of a factory before and after a Unit Production System was installed yielded very practical and positive results. From the number of firms which requested the report and/or visited the cooperating contractor it became obvious that this analysis by a third party, independent of the equipment vendor and garment supplier, was believable and surely resulted in the accelerated adoption of unit production technology by the industry.

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This kind of project should be repeated for significant pieces of other technology which are not being readily adopted by the whole industry and military contractors. Some of these technologies are CAD, NC fabric cutting, automatic seamers, programmable sewing machines, EDI, and Product Data Management. The emphasis should be on the effects of applying the technology as regards manufacturing and procurement systems productivity as opposed to strictly individual work station efficiency improvement.